In the Title

Kindly replace the Title with the following:

~~METHOD~~PROCESS FOR ~~IMPROVING~~IMPROVEMENT OF FINGERPRINT IMAGES ~~OF~~

~~FINGERPRINTS~~

In the Specification

Kindly replace paragraphs [0001] through [0003] with the following:

Related Application

      This is a §371 of International Application No. PCT/FR2005/050010, with an international filing date of January 7, 2005 (WO 2005/071602 A2, published August 4, 2005), which is based on French Patent Application No. FR 04/50055, filed January 9, 2004.

Technical Field

      The ~~present~~ invention refers to the field of image processing, ~~The present invention refers~~ more specifically to a process for improving the fingerprint images with the aim of facilitating extraction of the parameters necessary for print recognition.

Background

      ~~The former art is already acquainted, though application~~ WO 03/079274, ~~with~~ discloses a process for improving fingerprint images, in which the recorded images are processed based on blocks of the initial image using Gabor filters adapted to characteristic quantities of each block. More specifically, the processing described comprises the following successive stages:

-      calculation of the local gradients G of the initial image;

-      calculation of the spacing R between the lines, corresponding to the frequency;

-      division of the initial image into different blocks;

and subsequently, for each block:

-      calculation of the orientation of the block and the variance of the orientation using the gradient G;

-      calculation of the frequency of the block and its variance using R;

-      construction of Gabor filters based on these parameters;

-      filtering of the blocks using the Gabors;

-      addition of the filtered block to the final image.

Kindly replace paragraph [0005] with the following:

~~The former art is also acquainted, through the publication of~~ Hong et al. "Fingerprint Enhancement" ~~with~~discloses a print image improvement method. This publication mentions the value of filtering the image by Gabor filters before making choices of orientations. However, the publication uses an average frequency set here at 60 cycles per image height for such Gabor filters.

Kindly replace paragraphs [0007] through [0010] with the following:

~~One is also acquainted, through the scientific publication~~ XP_010614029 of Okombi-Diba et al. "Segmentation of spatially variant image textures"~~, with~~ discloses a process for ~~characterising~~characterizing the image textures and segmenting this image according to these textures. The process is based on the use of Gabor wavelets by Gabor filters. Such a process is only used for texture determination.

Summary

    This invention relates to a process for improving a fingerprint image including normalizing an initial image, determining a useful zone of the image, cutting the image into a plurality of blocks, calculating an FFT of each block, determining frequencies of image blocks based on the FFT, applying Gabor filters of parameters determined by the frequencies, and determining orientations of the image based on filtered images derived from the Gabor filters.

Brief Description of the Drawings

    Selected, representative aspects of the invention will be better understood with the aid of the description, given here as a mere explanation, of a method of realization of the invention, with reference to the appended figures in which:

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Fig. 1 illustrates the pre-processing of the raw image; and

Fig. 2 illustrates improvement of the image by filtering.

Detailed Description

~~The present invention intends to~~We compensate for the disadvantages of the former art by calculating the orientations of the image after filtering adapted to the image. In order to do this, ~~the present invention is of the type described above and is remarkable, in its broadest sense, in that it proposes~~we provide a process for improving a fingerprint image comprising at least the stages of:

- ~~normalisation~~normalization of the initial image;

- determination of the useful zone of the image;

and characterised by the fact that it comprises in addition successive stages of:

- division of the image into a plurality of blocks;

- calculation of the FFT of each block;

- determination of the frequencies of the image blocks based on the aforementioned FFTs;

- application of Gabor filters of parameters determined by the aforementioned frequencies;

- determination of the orientations of the image.

~~Favourably~~Favorably, the aforementioned blocks comprise overlapping zones.

Kindly replace paragraphs [0013] through [0014] with the following:

~~Favourably~~Favorably, in case of irrelevance of one of the aforementioned frequencies, the aforementioned frequency is recalculated based on a function of the initial FFT.

According to ~~a method of realisation~~one aspect, the irrelevance of one of the aforementioned frequencies is assessed in relation to a predetermined threshold.

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Kindly replace paragraphs [0016] through [0023] with the following:

~~Favourably~~Favorably, the aforementioned Gabor filters have as orientation parameters 0°, 22.5°, 45°, 67.5°, 90°, 112.5°, 135° and 157.5°.

Preferably, the aforementioned stage of determining orientations comprises ~~the stages consisting in~~:

- reconstituting images based on the aforementioned Gabor filtering of the aforementioned blocks;

- calculating the average intensity of each filtered image for zones of a predetermined size;

- creating a new image of orientations containing the orientation of the block of the highest intensity;

- creating a new quality image containing the intensity of the block of the highest intensity;

- filtering of the aforementioned image of the orientations.

According to ~~a method of realisation~~another aspect, the process additionally comprises stages of creation of a merged final image based on the aforementioned orientations and ~~binarisation~~binarization and ~~skeletonisation~~skeletonization of the aforementioned merged final image for detection of the fine details.

~~The invention will be better understood with the aid of the description, given here as a mere explanation, of a method of realisation of the invention, with reference to the appended figures in which:~~

- ~~figure 1 illustrates the pre-processing of the raw image;~~

- ~~figure 2 illustrates improvement of the image by filtering.~~

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Illustrated in ~~figure~~Fig. 1, the first functional block ~~according to the invention~~ is a pre-processing block. It allows the image to be subsequently processed under satisfactory conditions.

This block takes on input the raw image Ib derived from the fingerprint sensor and applies various different pre-treatments to the raw image. These pre-treatments are of a known type and ~~consist of normalisation~~include normalization of the image, in addition to an initial determination of the useful zone of the image, i.e. the zone containing the print image.

For global ~~normalisation~~normalization, the overall mean of all the pixels of the image is established, in addition to the standard deviation at a predetermined value, for example mean = 127 and standard deviation = 50 in shade of grey.

Thus, if N=L*H is the total number of pixels of the raw image and Ib (x) is the value of the xth pixel of the raw image, one calculates:

$$M_b = \frac{1}{N}\sum_{x=0}^{N-1} Ib(x)$$

and subsequently the deviation $D_b = \sqrt{\frac{1}{N}\sum Ib(x)^2 - M_b^2}$

and the new ~~normalised~~normalized image is, if the new mean has been set at M_0 and the deviation at D_0:

$$In\ (x) = M_0 + \frac{(I_b(x) - M_b) \times D_0}{D_b}$$

Kindly replace paragraph [0026] with the following:

Based on this re-cut image Ip, the functional block of improvement of the image itself illustrated in ~~figure~~Fig. 2 is applied.

Kindly replace paragraph [0031] with the following:

Conditionally, new processing is employed for blocks the quality of estimation of the frequency of which is too poor. The FFT is globally multiplied by itself in order to increase the frequency peaks and eliminate parasitic low frequencies. A ~~normalisation~~normalization is subsequently performed so as not to generate any saturated data. More specifically, if ReFFT is the real part of the FFT and ImFFT is its imaginary part, one calculates for each point, pseudoMagnitude(x) = $(\text{Re}FFT(x)^2 + \text{Im}FFT(x)^2)^n$ with n=0.25 typically and one selects as new coordinates of the FFT: ReFFT(x) = ReFFT(x)*pseudoMagnitude(x) and ImFFT(x) = ImFFT(x)* pseudoMagnitude (x). ~~Normalisation~~Normalization is performed in this case by dividing each complex value of the FFT by the Max of the magnitudes of the block.

Kindly replace paragraphs [0041] through [0042] with the following:

The merged image obtained in this manner is subsequently ~~binarised~~binarized and ~~skeletonised~~skeletonized continuously in order to allow detection of the fine details, with the quality map qual2 serving to determine the relevance of each fine detail.

~~The~~Various aspects of the invention ~~is~~are described in the preceding paragraphs as ~~an~~representative example~~s~~. It is understood that ~~a specialist~~one skilled in the art is capable of ~~realising~~realizing different ~~variants~~aspects of the invention without ~~forasmuch~~ departing from the ~~framework~~scope of ~~the patent~~this disclosure as defined in the appended claims.